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THE SCIENTIFIC MONTHLY

JUNE, 1919

THE PLACE OF MODERN LANGUAGES IN RESEARCH, PARTICULARLY GEOLOGICAL RESEARCH

By the late Professor JOSEPH BARRELL[1]

YALE UNIVERSITY

TRAINING for scientific research is given in courses of instruction which lead up to the degree of doctor of philosophy. The rules of almost every graduate school require that a reading knowledge of French and German must be attained by every candidate for this degree, irrespective of his department of study. Since these languages are specified and the student's time is limited, it means practically that the study of other languages is discouraged. The modern language requirements for advanced scientific study are thus run into a single stereotyped mold. It is true that a department may require at its option any number of additional languages and that substitution of some other language for French or German is possible by special vote of a faculty, but the very purpose of a general rule is to discourage exceptions. Inflexible rules, however, do not make for progress and adaptation to new conditions. The conclusion reached in this article is that the present almost universal rule set by the *graduate schools* of our universities requiring all candidates for the doctor's degree to possess "a reading knowledge of *French* and *German*" should be modified to "a reading knowledge of *two modern languages other than English* to be selected in view of the student's field of research with the approval of the *department of principal work* and the dean." This is the rule already in force at the University of Chicago.

It is to be presumed that at least four students out of five would still be advised by their departments to offer French and

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[1] Professor Barrell, one of the most distinguished American geologists, died on May 4. We hope to print next month an obituary appreciation.—Editor.

German, but if the fifth student submitted French and some other language there would be fostered in this country a more cosmopolitan knowledge of the learning of the world. The question of greater liberty in the choice of modern languages should turn upon the standing of German scholarship in each field of learning rather than upon prejudices based on their ruthless conduct of a war of murderous aggression. But if it can be shown that in some lines of research a knowledge of some other language is comparable in importance to German, then the present distaste for things Teutonic may reasonably be taken into account.

The following article has been written from the standpoint of a geologist, but it touches on matters common to many sciences, and it seems time for consideration of this problem in these other sciences as well. The need for a good knowledge of modern languages is as great, if not greater, now than ever before, but other languages besides the traditional German and French seem destined to come forward in the future for worthy consideration. In so far as original work is concerned, the writer has believed for some years that German science has been over-rated, and that in geology at least the average quality of German writing is distinctly below the standard in English. For the study of volcanoes and earthquakes Italian is more important than German. To economic geology the Germans have in recent years contributed little of importance in comparison with that published in English and French.

If the quantity of scientific literature is made a test of the question it is clear that English and German are the two most important languages. But the quantity and quality of scientific work in German in the different fields of science is very uneven. Germany has been preeminently the land of reviews and compendiums, which, as Doctors E. B. Wilson and P. G. Nutting have recently pointed out, call for industry rather than fertility in real research. If the English-speaking nations should see that henceforth such publications are fostered in their own tongue, a considerable part of the need for German would be obviated. The Smithsonian Institution has for its fundamental purpose "the increase and diffusion of knowledge." The Congressional Library is the central repository of printed matter for the United States. From the standpoint of national interest it would be eminently appropriate and wise for Congress to provide that the United States, the wealthiest of the English-speaking nations, should publish under its auspices digests in English of the scientific literature of the world. Nothing else would so soon shake us free from the insidious scientific control of Germany. Such work would be equally valuable from another standpoint, as it would make known the literatures of Russia, Japan, Brazil, and such other nations as are now closed to nearly all American scientists for the double reason that the publications are not accessible and could not be read if they were accessible.

The International Scientific Catalogue already lists and classifies all titles. An editorial board should in addition give digests which should range from a single sentence for unimportant articles to translations of an entire work where in the judgment of editors the exceptional value warrants such a course. Such annual digests should be sold on a cost basis to the general public, but presumably should be donated to a certain number of the larger libraries designated as public repositories. Under such a system the government would be called upon to supply the organization and just enough capital to assure the success of the enterprise.

In view of the ever-increasing quantity of scientific and technical contributions it is a question if it would not be also to national self interest to have in census years a census taken of the increase of knowledge in the previous decade in the form of a series of volumes, drawn from the literature of the entire world. Such a plan might well be placed in the hands of the National Research Council or the Smithsonian Institution. The ablest men in their respective fields should be sought as authors of such work in order that the results should be authoritative. If such a plan had been in vogue for 1900 and 1910 this nation might not have been handicapped to such a degree in chemical industry as was the case at the opening of the great war.

There is large need for the government to foster research on the consequences of research. If such a body as the National Research Council had existed before the war there might have emanated from it investigations on the possible effects of the American inventions of the submarine and the aeroplane. Because of the blindness of the people those great inventions were permitted to become a menace to the democracy which gave them birth and cost through their destructiveness in ruthless warfare billions of dollars before their antidotes were discovered and applied. Here is a striking illustration of the need of parallel research to control the misuse of research. The need for such controls could have been predicted long before their immediate solution became a matter of life and death. In such a far-seeing policy of research upon the consequences of research, an initial step would be to make the conclusions from all important scientific literature immediately available in the

English language. As a second step, a more comprehensive survey on subjects of vast national importance, but on subjects which, because they affect the future welfare of mankind, are beyond the vision of the politician or the means of the individual scientist, could be undertaken with value in the form of a census of knowledge as suggested, supervised by committees of leading scientists at the opening of each decade.

Even if such a plan should be adopted there would be nearly as much need as previously for modern languages in the training of scientific research to enable the investigator to do intensive work in his particular field, but such intensive work would less exclusively require the use of German than is now the case. Italian, Spanish, Russian or other languages would have more opportunity for consideration. In the course of the next decade it is probable that the quantity of German science will notably decrease. It was an inflated product containing, however, much of real value. In the lean years which lie ahead for Germany the inflation is likely to diminish and, more regrettably, the good work as well. Scientific research is largely a product of prosperity as well as of ability.

But the foregoing deals only with the value of modern languages as means of library research. This is a fundamental side, but an even more fundamental side to research is first-hand contact with the subject matter in museum or laboratory. What would be thought of an institution that should give a doctor's degree in chemistry to a student who, no matter how conversant with chemical literature in English, French and German, could make only limited use of a laboratory? It would seem that in sciences which involve travel for their prosecution, the idea that only French and German are acceptable languages for the doctor's degree is based on a narrow view. The world is a great laboratory, even more a series of great museums as wide as nationalities. The neophyte in research should be provided with French and German as keys to libraries, but he needs keys at least as much to the laboratory or museum from which he must gather at first hand his facts. In geology, geography or anthropology, if his work should take him beyond the bounds of the English-speaking countries, a good knowledge of the language of the land would be as valuable a key for research as an equal knowledge of German.

Of course, the ideal plan would be for the student to acquire French, German and the language of the country in which his work is to be carried forward. But many good scientists are rather poor linguists, art is long and time is fleeting, and the practical question is—if only two modern languages are required, what two will be of most value for original research. A traveler can pick up in a few weeks or months a sufficient knowledge of a langauge to enable him to travel in a strange country, but such a half knowledge is very different from an ability to search out local literature, to read freely, to speak idiomatically, and to establish intelligent cordial working relations with provincial inhabitants.

To test the value of modern languages in geological research the writer sent a questionnaire to all those members of the Geological Society of America who had been elected to membership from 1903 to 1910, both years inclusive. This society maintains high professional standards for admission. Before being eligible to election candidates must have several publications to their credit and be active in research. The group of members chosen includes as a class men whose training was obtained at a time after good graduate departments in geology had been built up in American universities and who have been working geologists long enough for them to have tested the values, both for their work and their general education, of the subjects studied in the graduate schools.

Answers were received from thirty men who held the degree of Doctor of Philosophy. Excluding one who stated that he had long since forgotten his modern languages, the answers are tabulated as follows:

Value of Modern Languages in Geological Research

Answers by 29 men holding the degree of Doctor of Philosophy, elected to the Geological Society of America in the years from 1903 to 1910, both inclusive

Degrees received from the following universities

California	1	George Washington	1	Toronto	1
Chicago	5	Germany	2	Wisconsin	3
Columbia	2	Harvard	3	Yale	5
Cornell	1	Johns Hopkins	5		

Chief fields of geologic work, most men having worked in two principal fields

University teaching and research	23	Museums	6
Governmental surveys	18	Private economic work	5

Special division of geologic research, most men having worked in two divisions

Areal	6	Stratigraphic	8
Glacial	7	Paleontologic	10
Physiographic	7	Economic	9
Petrographic	4		

Reading knowledge required for their doctor's degree

French	yes 24, no 3	German	yes 25, no 1

Rough estimate of foreign literature actually read in post-graduate study for doctor's degree

(Over 500 pages = much; 500–100 pages = some; 100–1 pages = little)

French	much 5,	some 11,	little 7,	none 3
German	much 7,	some 13,	little 7,	none 1

Opinions as to whether the information was important and inaccessible in English

French	yes 13, no 9	German	yes 14, no 10

Value of modern languages in later geologic research

French	necessary 15,	advantageous 12,	little use 1
German	necessary 17,	advantageous 10,	little use 2
Spanish	necessary 6,	advantageous 2,	little use 6

Chief use of language in order of importance

French	articles, reviews, manuals, travel, correspondence
German	articles, reviews, manuals, travel, correspondence
Spanish	travel, articles, correspondence

Number of foreign languages which should be required for a Ph.D. in geology

In favor of two languages	22
In favor of one language	5

Opinions as to whether a language should be required or optional

French	required 19,	optional 7
German	required 17,	optional 8
Spanish	required 3,	optional 12

Other languages (Italian, Russian, etc.), optional, several.

Should a student be permitted to offer any language of his choosing as a second required language?

Yes	11	No	12

The contributors to this questionnaire are all productive scientists. Their answers give testimony to the value of modern languages for geological research. If some graduate students should question the amount of time asked of them for the study of modern languages, an inspection of this tabulation should convince them of the desirability of modern languages in research of the highest grade. In certain fields of work and for considerable periods of time a knowledge of foreign languages may not be needed. Then suddenly they may become for some topic vitally essential, and the scientist to whom they are unavailable may realize that doors to knowledge are closed to him which are open to his competitors.

A considerable number of letters were received supplementing the answers to the questionnaire. A few writers consider the present time inopportune for discussion of this question, the majority, however, consider that this is a very appropriate time for its consideration. Most of the contributors discuss the use of languages wholly from the library standpoint, some, however, lay stress also upon languages as a medium of obtaining information in the field. Still others consider that the subject is hardly worth discussion because German and French are so clearly the necessary languages. The majority of the writers, however, are of the opinion that some degree of freedom of choice is desirable, the final decision to rest with the department of study and not with the student. Limitations of space prevent the publication of all of these communications, but several quotations have been selected, the writers having kindly given consent to the use of their names.

Whether the Germans are our friends or our enemies, there is no denying that their contributions to science are enormous. To-day, in my opinion, the absolute scientific value of the world's various languages puts them in approximately the following rank: (1) English, (2) German, (3) French, (4) Italian, (5) Russian, (6) Japanese, (7) Spanish. If all the Scandinavian languages are combined they perhaps rank above Japanese.

Moreover, the Japanese may be publishing more original material than I realize, but I have an idea that their publications are largely taken from those of other countries. Of course the estimate here attempted is very rough, but the method has a real value and would have much more if one had time to use it as the basis of an actual statistical study.

E. HUNTINGTON,
Captain, Military Intelligence Branch
War Department, Washington, D. C.

Am glad you are bringing up the matter for discussion. The Germans have plainly abused the deference which has previously been paid to their language. To my mind, for a considerable number of years prior to the war, they had attained such a self-sufficiency that they paid practically no attention to what the outside world was doing in science—except to make frequent raids and incorporate advances that had been made by others in such a manner as to make them appear their own. Moreover, I have already been placed in a position where I should have known Spanish. In vulcanology, it is wise to know Italian and with the opening up of Russia and Siberia, some serious students should have the opportunity of tackling the Russian language.

J. AUSTEN BANCROFT,
Department of Geology,
McGill University.

In this connection perhaps I ought to state a little more explicitly my general point of view. The Ph.D. degree, while ordinarily the end of formal graduate work, is of course only a preliminary to the larger field of scientific research. For that reason a student should get while in college the linguistic equipment necessary not merely for his three or four years of graduate study, but for his subsequent career as a scientific investigator. To illustrate, I can well imagine that one of our students could go through our graduate school, write an admirable thesis, and get his doctorate without knowing any language but English; but as a rule, I should think it very unwise for a man to attempt to become a geologic scientist unless he could read two or more of the most important foreign languages. At almost any stage in an investigation he may find that indispensable material is contained in French or German publications, or sometimes even in Italian and Russian.

Undoubtedly five or six languages would be an advantage to the average geologist, but it seems unreasonable to require so many. Probably two is not an unreasonably large number, and for those two it seems to me French and German are by far the most important for geology.

ELIOT BLACKWELDER,
Department of Geology,
University of Illinois.

I venture to supplement this questionnaire with a few comments, expressing my position more exactly.

1. French I regard as the most essential foreign language, not merely because of its important scientific literature, but because of the training which it affords in clear thinking, exact reasoning and especially in concise and luminous presentation of ideas. As the amount of literature increases we need to place more and more emphasis on these features.

2. The relative utility of German has changed considerably since I was at college. English and American scientific literature has advanced along practical and progressive lines, while German literature, although huge in bulk, has, I think, deteriorated in quality, especially in critical judgment and "intellectual honesty." Nevertheless, German remains essential for the reviews and summaries of literature in the various sciences, and for similar compilation works which have no equal in English or French. Moreover, some of the best scientific work past and present is in German and untranslated. A large part of Dutch, Swiss and Scandinavian geology and paleontology is written in German. A knowledge of German and English also makes Dutch, Danish-Norwegian and Swedish easy to acquire if necessary.

3. Spanish I have found necessary, and regard it as likely to become more important with the development of South and Middle America. It is one of the four world-languages, and it might almost be regarded as necessary rather than optional. It is well to remember that a passable acquaintance with Latin is not only of great value in understanding French, and considerable in English, but enables one to pick up Spanish, Italian and Portuguese with very little difficulty. I do not say that Latin should be necessary, but I do think it should be encouraged and made one of the optional languages.

4. It is difficult to foresee what may be the development of the Slavic group of languages in the immediate future. At present they have little scientific importance, but Bohemian and Russian may expand in the near future, possibly others of this group may come up with the spread of popular free governments and education of the masses. The present trend toward the development of nationalities is very likely to involve the growth of vernacular scientific literatures to such an extent as to afford a very grave problem. There will be too many languages for any one to have

command of all that are of any importance to his scientific work. We shall have to devise some international system of translations and abstracts. This last I regard as the most important matter that scientific societies have immediately before them.

I wish I could see it as possible to do without German science. It is a perpetual irritation to me to have to wade through the obscure, clumsy, muddy bulk of it. And I have always thought that in geology and paleontology at least, German science was much overrated, and in the last twenty years much of it was astonishingly silly—there is no other word for it. But you can not master your subject without going through the summaries and abstracts of what has been done, and more careful reading of the contributions of the five or ten righteous men who redeem that particular linguistic Gomorrah from destruction and oblivion.

W. D. MATTHEWS,
American Museum of Natural History.

For appointment to the United States Geological Survey only one foreign language is required, either French or German, the test consisting in the translation of scientific matter into English. The modern language counts as ten per cent. of the total examination for the lowest grade. This appears to be a very proper rating of the minimum requirement. Promotion may be made to all grades without further language examination. This is no argument, however, against the value of a larger knowledge of languages. For special work, special requirements may be set, and under date of January 16, 1919, Dr. G. O. Smith, Director of the Survey writes as follows:

> In connection with the subject of language requirements you may be interested to know that the Survey has asked the Civil Service Commission to hold an examination for persons qualified to undertake certain special investigations regarding mineral deposits. For this examination the Geological Survey has a language requirement specifying that the candidate must make translation of certain scientific material in two of the following five languages: French, German, Spanish, Russian and Portuguese.

In regard to the value of Spanish, the correspondence shows a wide range of opinion. One economic geologist writes:

> Spanish is merely a means of obtaining a fee. In Spanish-speaking countries one needs the language: also one needs a raincoat. From the standpoint of literature, to the economic geologist the Scandinavian and Russian languages are much more important.

The rejoinder is that if one is traveling simply for a fee in Spanish-speaking countries the language is merely the means of obtaining the fee, but if one is traveling for scientific research the language, by bringing the investigator in contact with the field, is an important means of obtaining scientific knowledge. Another economic geologist who is a university professor expresses a very different opinion. He writes:

> I feel that it is necessary that the men whom I train specially in oil geology should have Spanish. Spanish is the most valuable field language for them and the second most valuable reading language, there being more literature of moment to them in Spanish than in French.

A number of writers, although favoring the modern language requirement, emphasize what they believe to be an unnecessary waste of time spent at a late stage in the student's education in learning to read modern languages by means of plays and poems. One contributor expresses himself very vigorously in regard to a system of education which provides no opportunity for learning languages until the years of early youth are past and the boy or girl has lost that keenness for memory work which language requires, then forces languages on him when the memory faculty has become subordinated to a more or less highly developed analytical and reasoning faculty. He says:

> I base these views on my own mental development. I recall that I found it a pleasure around the years of ten to twelve to learn history *verbatim*. A little later of course I learned that this was a highly unsatisfactory way to learn history. If my teachers at that time had been working under an intelligent system I could have acquired then with relative ease and pleasure two or more foreign languages before I ever entered college. When I reached college I had lost the ability and taste for pure memory work. Result,—I wasted years in getting a very mediocre knowledge of Latin and German and came to hate both worse than the Teuton hates righteousness. You men who teach ought to get clearly into your heads the fact that a boy's mental angles change as rapidly and completely as do the angles of an ammonite's suture line as it approaches maturity. If a boy needs one or five foreign languages why not install the machinery in the schools for giving him those languages while he is still at an age which makes it easy for him to take either whooping cough or French? The coming of the adolescent period will most certainly greatly reduce his chances of taking either. Can't the teaching profession learn anything from such people as the French Canadians who teach English at an age which gives the average French Canadian a fair command of English notwithstanding the very few years which he is able to spend in school?
>
> I insist that for the average youth consideration of his language problem is postponed too long by ten years. It should be taken up in the primary grades, not in the university. It may to-day be impossible in the village and rural schools to teach foreign language at the proper age, but it can easily be done in the cities. With the passing of America's former policy of splendid isolation should naturally come a reconsideration of the entire language-teaching problem and you are selecting a propitious time to discuss it. But I hope you will see the importance of taking up language while the boy is still in the language stage of his ontogeny. I am an example of a man who had to take up this subject after that stage was passed and, although I spent years on two foreign languages, can claim a mastery of no language other than English in spite of my answers to your questions.

A great deal is assumed regarding the scientific productivity of this or that nation, but measurements are seldom attempted. The quantity may be measured by means of the International Scientific Catalogue, but quality, consisting in origination of new ideas, or elaboration of old ones, is less easily evaluated. The International Scientific Catalogue is an impartial measure for those nations which contribute to it, since the data are supplied by each nation and each is supposed to see that its own material is complete. It is not complete for the whole world, however. For example, no Latin American country contributes, with the result that the Spanish language is barely represented in the catalogues of the geological sciences. The publications in Spanish and Portuguese are mostly of a descriptive rather than of a critical nature, but there is much of a grade which would find its way into the catalogue if it had been published in English, French or German.

To test the quantity of scientific work in mineralogy, geology and paleontology in English, French, German and Italian the year 1908 was selected as previous to the great war and the one in which a new classification first became effective in geology. The results are tabulated as follows, the data being supplied by Miss Withington of the Yale library:

MINERALOGY, 1908[1]

	Number of Titles	Classification				
		General	Mineralogy	Petrology	Crystal	Sum
English	812	41	1336	266	97	1740
French	175	16	428	95	64	603
German	733	46	947	215	284	1492
Italian	147	2	271	73	23	369
Others	202	4	7	1		12

GEOLOGY, 1908

	Number of Titles	Classification								
		General	Dynam. Geology	Petrography	Tectonic Geology	Metamorphism	Experimental Geology	Stratigraphical	Topographical	Sum
English	613	86	283	41	54	9	10	278	110	871
French	506	70	132	11	74	9	1	313	73	683
German	782	104	422	52	105	6	3	425	146	1263
Italian	410	74	248	17	12		2	72	46	471
Others	234	21	79	5	20			117	41	283

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[1] Under Mineralogy all titles in Russian, Japanese, etc., are listed under their translations with no indication of the language of the text. They are included for the most part in the French and German titles, but a few are in English.

Paleontology, 1908

	Number of Titles
English	371
French	180
German	316
Italian	91
Others	75

Relative Quantity of English and German Work, 1908

	Mineralogy			Geology			Paleontology		
	Number of Titles	Average Length in Pages	Total Pages	Number of Titles	Average Length in Pages	Total Pages	Number of Titles	Average Length in Pages	Total Pages
English	812	30	24,360	613	39	23,910	371	50	18,550
German	733	13	9,530	782	45	35,190	316	38	12,010

The total number of pages is obtained by multiplying the number of titles by the average length. The latter was obtained by taking sample pages of the Catalogue and may be in error as much as five per cent.

The ratio of German work in geology in 1908 to that in English seems to have been above the average. For 1912, the last volume published before the outbreak of the war, the titles are distributed as follows:

Geology, September, 1911, to September, 1912

	Number of Titles
English	1,277
French	310
German	1,100
Italian	551
Others	363

To properly appraise these tables it should be noted that the German catalogues show a padding which tends to give them an undue importance. It has been stated that under mineralogy a considerable part of the articles in Russian, Japanese, etc., have had their titles translated with no other indication of the language of publication than the name of the author and source of publication. German appears to have gained the most by this system.

The same article is often listed under two or three of the subjects mineralogy, geology and paleontology. It is probable that the German list has been expanded in this way in geology somewhat more than the English list.

Many minor articles in English, such as reviews, summaries, etc., have been omitted from the English list. It is difficult to compare the English and German catalogues in this respect, but the writer's impression of a large part of German scientific literature is that it does not consist of original work so much as of reviews and compilations. It seems as though writing in Germany had become a profession, promotion of young men being determined largely by the quantity of writing. Mediocre minds short in ideas but long in industry could turn out hack work and find mediums for its publication.

It is to be anticipated that during the coming generation there will be less of this grade of writing in Germany, as the breaking up of the empire will probably tend to reduce the number of unessential government positions, for university professorships are there government jobs. The energies of mediocre young men and the governmental income will no doubt be largely consumed in paying to the allies the cost of the German joy of war. Furthermore, a considerable quantity of writing in German has been the product of foreign students who have studied in Germany, or of scientists who have preferred that language for publication instead of their native tongue. It is to be presumed that there will be a marked diminution in these voluntary contributions.

A considerable number of years should in reality be compared to gain an accurate measure of the relative contributions of the different languages. This is partly because the manuscript for these volumes of the International Catalogue was received by the editors at irregular times and the content is not restricted to a single calendar year. Actual productivity also shows considerable fluctuation. The result is that the number of titles in geology for 1912 shows a great expansion in both English and German over 1908. Of this quantity of geological publications perhaps two thirds of that in English in 1912 is to be credited to North America.

The measurement of bibliographies tests the quantity of scientific literature but not its quality. Some measure of quality and importance to American students may be obtained in another way, by noting the relative number of citations to works in the several languages which are given in treatises of comprehensive scope by authors who have made a special study of the literature. A great range may be observed in this matter, owing to the fact that illustrations may often be selected from one language as well as another. The analysis of the following list of standard works is illustrative.

To discuss these examples in order. English-speaking geologists are greatly indebted to F. W. Clarke. Such a work as his data of geochemistry renders them largely independent of

Germany in that field, as it is seldom necessary to go back of the volume to the original source. In this field of chemical geology the Germans show at their best, as it consists largely of a compilation of chemical data developed in the laboratory.

PERCENTAGES OF REFERENCES TO WORKS IN ENGLISH, FRENCH, GERMAN, AND OTHER LANGUAGES

	English	French	German	Other
Clarke, "Data of Geochemistry:"				
Chap. IV. The Ocean	60	17	16	7
Chap. XII. Decomposition of Rocks	50	10	36	4
Harker, "Natural History of Igneous Rocks"	47	14	37[2]	2
Daly, "Igneous Rocks and Their Origin"	70	10	15	5
Grabau, "Principles of Stratigraphy"	71	4	25	0
Lindgren, "Mineral Deposits"	86	6	7	1
Leith and Mead, "Metamorphic Geology"	92	0	8	0

A prominent field of German geological work is in the petrography of igneous rocks. A. Harker, as shown in the table, gives 37 per cent. of his references to writings in German, but, as noted above, two fifths of these are to Brögger and Vogt, two Scandinavian geologists. The remainder of the German references are to a very few writers.

Daly, Grabau and Lindgren, geologists of the widest training, have all studied in Germany as well as in other countries. Their works listed in this table were published in 1913 and 1914, before the self-revelation of the Germans began to change the good will of the English-speaking world.

Daly's work lies in the same field as Harker's, but is fuller in its bibliography and makes much larger use of North American literature.

Grabau's work of 1,185 pages on the "Principles of Stratigraphy" is really much broader in scope than its title indicates, but its central thesis is the interpretation of the sedimentary rocks. It is dedicated to Walther, a German professor who has done much in this field, under whom Grabau has studied, and a considerable part of the value of the treatise is owing to the fact that more than any other recent work it brings into English the best of German geology. The bibliographies are full and excellent, yet notwithstanding the special search of German literature, only 25 per cent. of the citations are to works in that language.

Lindgren's volume on mineral deposits is devoted to the discussion of principles illustrated by examples. Notwithstanding his familiarity with a considerable number of European languages, between eight and nine tenths of his work is traceable to sources in the English language, but no doubt where equally good examples were available those from American sources have been preferred.

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[2] Forty per cent. of the references in German are to Brögger and Vogt, two Scandinavian geologists.

In "Metamorphic Geology" by Leith and Mead, the sources of chemical analyses as well as references to literature were counted to ascertain the relative proportion of source materials. The eight per cent. of references to German origin are mostly to analyses and to about three German writers.

From this study of quantity and quality we may conclude that although German geological literature is roughly equal in quantity to that in English it is not by any means as important in the advancement of knowledge of the earth. When the geographic factor is included and the relative value estimated for American investigators it may be stated that for works of comprehensive scope, dealing with principles rather than descriptions of examples, the literature in German is about one tenth as important as that in English. For studies in North American regional geology rather than on the principles of geology German may almost be ignored.

In geologic writings perhaps on the average half of the references are to illustrations rather than to principles or to original sources of ideas. Such illustrations could be selected from other regions and other languages without intellectual dishonesty. In view of the self-sufficiency and lack of courtesy which characterized much of German writing for many years before the advent of the world war it would seem to be within the limits of good taste to avoid mere courtesy references to German literature.

In conclusion, it should be borne in mind that the field of literature in every subject has become so vast that the student can cover only a portion. The same principles may be found developed in manuals in several languages. It seems time to emphasize the value of languages other than German for regional studies of literature and for field research. Although, in general, students in geology should be advised to study German as the most important member of the Teutonic group of languages and French as the most important living Latin tongue, yet the arguments are strong in favor of permitting students in certain branches of geology, if they find distaste or difficulty in the study of German, to substitute Spanish, Italian or some other language of importance to their work. Such substitution, furthermore, should be by permission of those in direct charge of the work and not require the setting in motion of machinery necessary for the breaking of a rule of a graduate school.